

NUTRITIONAL PROFILING AND SENSORY EVALUATION OF NOVEL HOT CHOCOLATE RECIPES: A COMPARATIVE STUDY WITH A COMMERCIAL BRAND

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ABSTRACT

Aim of the Study: The study aimed to develop and evaluate two new hot chocolate recipes (P1 - Red Recipe and P2 - Green Recipe) and compare them with a commercial hot chocolate product (P3 - "La Festa"). The focus was on creating recipes that are nutritionally comparable to natural or dietetic products, with reduced sugar and increased dietary fibre content. **Materials and Methods:** The study employed sensory evaluation methods, specifically the Mann-Whitney and Wilcoxon Sign Rank tests, to assess appearance, consistency, flavour, taste, and smell of the hot chocolate recipes. Additionally, a comprehensive nutritional analysis was conducted to compare the protein, lipid, carbohydrate, fibre, and caloric content of the recipes against the commercial product. **Results:** The sensory evaluation revealed that Recipe P1 significantly outperformed both Recipe P2 and the commercial product P3 in all tested attributes. Nutritionally, Recipes P1 and P2 were similar, both showing lower sugar and higher fibre content than typical market products. However, no significant sensory differences were noted between Recipe P2 and the commercial hot chocolate P3. **Conclusions:** The study concludes that Recipe P1 is superior in sensory qualities with a favourable nutritional profile, making it an appealing option for health-conscious consumers. Recipe P2, while nutritionally akin to P1, shares more sensory similarities with traditional hot chocolate, offering a healthier alternative without sacrificing familiar flavours. This research underscores the feasibility of creating healthier versions of popular beverages without compromising taste and sensory appeal.

Key words: cocoa, hot chocolate, recipe, bacteriostatic

INTRODUCTION

Cocoa beans are the essential raw materials in the production of chocolate and other cocoa-based products like hot chocolate. Freshly harvested, cocoa beans do not determine the chocolate flavour, the fermentation, drying and roasting are essential for the flavour along with other ingredients [1]. Cocoa is the primary source for the multibillion-dollar industry that produces chocolate and

associated products. The consumption is consistently growing with 3% each year, because of products diversity, accessibility and the consumer's demand [2].

Cocoa is well known for its antioxidants and has more phenolic antioxidants than most foods. The antioxidant activity is dominated by flavonoids, including catechin, epicatechin and procyanidins with favourable impact on vascular endothelium. Antioxidant effect

directly influence insulin resistance and reduce the risk for diabetes, protect the nerves from inflammation and the skin for oxidative damage of UV radiation if included in topical products. Other already scientifically recognized beneficial effects are cognitive function, satiety and emotional mood. Side effects of overconsumption are related to weight gain and the sugar percentage [3]. Chocolate is perceived as fattening food because of energy density but studies show that small amounts of cocoa [4, 5] or dark chocolate [6] in daily dose of 25g (125kcal) slightly increase body weight after 3 months but 6 g (30kcal) consummate daily is not associated with any weight gain [7]. The beneficial effects of cocoa are counteracted by the quantity of added sugar, form of ingested sugar, frequency and physical consistency, Sugar has a well-known and demonstrated cariogenic effect. The chocolate form and frequency length of time affect the teeth if are exposed to sugar [8]. Cocoa or hot chocolate consumed in a liquid form has a distinct impact and effect to adhesive and sticky chocolate product [9-12]. Especially teens and young people consume chocolate and sugar on a large scale, but the moderate consumption, in a healthy form with a pleasant flavour reduce the side effects of sugar, and added additives which reduce the beneficial effects of cocoa.

MATERIALS AND METHODS

Two hot chocolate recipes P1 and P2, each with its own particularities, were sensorial evaluated on two research directions within the Discipline of Technology Prosthesis and Dental Materials at the "Victor Babeș" University in Timișoara, Faculty of Dental Medicine.

54 subjects were randomly recruited, the group being represented by students of the Faculty of Dental Medicine Timișoara. The subjects are in good health, without allergies to

the components of the hot chocolate recipes, without deficiencies in distinguishing the colors of the samples, all were showing availability and motivation to participate in this assessment and all signed the agreement consent.

The 100% hot vegan chocolate, antioxidant and anti-cariogenic, includes a base consisting of: cocoa powder-maximum of 12% fat (38%-mass percentage), carob powder (11.5%), coconut milk powder (38%), soy lecithin (1.9%), dried Stevia rebaudiana leaf powder (6.5%) and vanilla. Based on the recipe two new recipes are made by adding other types of vegan powder.

To the base recipe were added several types of plant powders, and two new recipes are obtained. The first newly recipe (P1) was obtained by adding blueberry fruits, black currant fruits, hibiscus flowers, pomace obtained from red grapes Cabernet Sauvignon variety and cloves, respectively for the second version (P2) was added sage leaves, echinacea, thyme, alfalfa, green tea, pomace obtained from white grapes of the Ceasla Dore variety and cardamom.

The P1 recipe consists of mixing the ingredients that constitute the base of the recipe -10g cocoa powder, 5g carob powder, 10g coconut milk powder, 0.8g soy lecithin, 1g stevia with: 0.2g blueberries powder, 0.2g black currants, 0.2g hibiscus, 0.1 g cloves, 0.2 g red beetroot and received the name "Red Recipe":

The P2 recipe (Fig.1.), "The Green Recipe". consist of mixing the ingredients that make up the base of the recipe with 0.1 g sage, 0.1 g Echinacea, 0.2 g cardamom, 0.2 g cinnamon, 0.1 g alfalfa, 0.1 g green tea, 0.2 g white tescovina. These plants were chosen due to their curative and bacteriostatic properties for oral and general health.



Figure 1. Hot chocolate powder P2.

For these recipes, several aspects of the finished product were taken into account to make it attractive for the consumers: to be in powder form, with a homogeneous appearance, pleasant color, taste and smell. All components were finely ground, precisely weighed and incorporated into the finished product. The hot chocolate was prepared by dissolving 27.7 g of chocolate mixture powder, P1 and P2 in 150 ml warm water, at a temperature between 75-80°C.

The two recipes were tested alongside a control sample, P3 product, commercial hot chocolate "La Festa". This is an instant drink based on cocoa and milk and contains: sugar, cocoa powder (dry cocoa solids: min. 15%), cocoa butter 10-12%, whey powder, glucose syrup, fully hydrogenated coconut vegetable fat, skimmed milk powder 2%, salt, thickener: carboxymethylcellulose, flavours, emulsifier: soy lecithin and the stabilizer represented by potassium phosphates. From a nutritional point of view, P3 has 391 kcal/100g, with a total protein of 5.3, lipids 5.4, carbohydrates 77.6, fibers 5.1 [10].

The research method was carried out by sensory analysis, the subjects being investigated by questionnaire. The sensory evaluation questionnaire reflected five important characteristics of the examined product: appearance or colour, consistency, aroma, taste and smell.

The appearance/color of a product is a primary attribute in making a quick decision about the product. This attribute refers to the clarity, the distribution of the ingredients and uniform quality of the colors. Regarding appearance/color, the subjects had to evaluate the receipt by choosing one of the following answers with different scores:

- Intensely colored, specific: 3 points
- Less intensely colored: 2 points
- Weakly colored: 1 point
- Incorrect: 0 points

Consistency can be defined as a manifestation of the mechanical, structural and surface characteristics of food and was evaluated according to the following criteria:

- Very good 3 points
- Good 2 points
- Weak 1 point
- Unsatisfactory 0 points

Regarding the taste, the following points were awarded as following:

- Excellent and fine taste 3 points
- Well pronounced taste 2 points
- Pronounced weak taste 1 point
- Inappropriate taste 0 points

Smell is the result of the passage of volatile compounds by aspiration through the nasal passage into the nasal cavity where they are perceived by the olfactory system. Smell was rated as following:

- Excellent, characteristic smell: 3 points
- Well-pronounced smell: 2 points
- Weakly pronounced: 1 point
- Inadequate: 0 points

The testing environment was noise-free and free of distraction for the participants. The samples were by respecting the imposed hygiene norms. In order to avoid overstimulation of the senses during the tasting of the three samples and to remove most of the residual taste of a sample. The oral cavity was rinsed with sparkling water and salted crackers were eaten before the tasting the next sample.

RESULTS AND DISCUSSIONS

The results were statistically processed within the Discipline of Medical Informatics and Biostatistics, from the "Victor Babeş" University of Medicine and Pharmacy, Timisoara. The "pair" test was used, so the results of products P1, P2 and P3 were considered as coming from the same subject who tasted the 3 products, under different conditions tasting the 3 products.

To determine which product has the significantly better appearance/colour, we refined the two-by-two sample comparisons by applying the paired non-parametric Wilcoxon Sign Rank test and found that P1 has significantly better appearance than P3 ($p=0.003$) (Fig.2.).

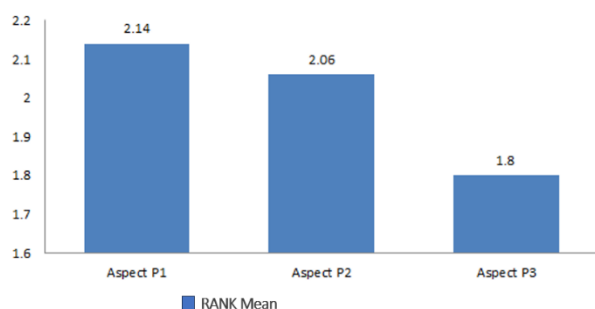


Fig.2. Descriptive statistics of product appearance P1, P2, P3.

To determine which product has significantly better consistency, was refined a two-by-two sample comparisons by applying the non-parametric Wilcoxon Sign Rank test and found that P1 has significantly better consistency than P3 ($p=0.001$) and then P2 ($p=0.003$) (Fig.3.).

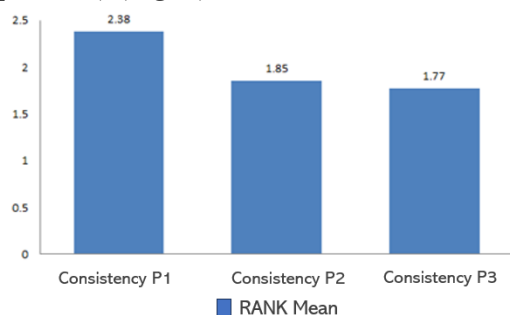


Fig.3. Descriptive statistics regarding product

consistency.

To determine which product has the significantly better flavour, we refined two-by-two sample comparisons by applying the non-parametric Wilcoxon Sign Rank test and found that P1 has significantly better flavour than P2 and then P3 ($p<0.001$) (Fig.4.).

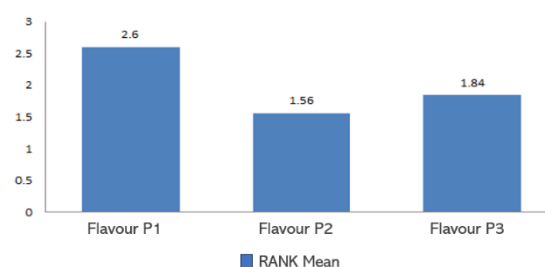


Fig.4. Descriptive statistics regarding the flavour of the products.

To determine which product has the significantly better taste, we refined two-by-two sample comparisons by applying the non-parametric Wilcoxon Sign Rank test and found that P1 has a significantly better taste than P2 and then P3 ($p<0.001$) (Fig. 5.)

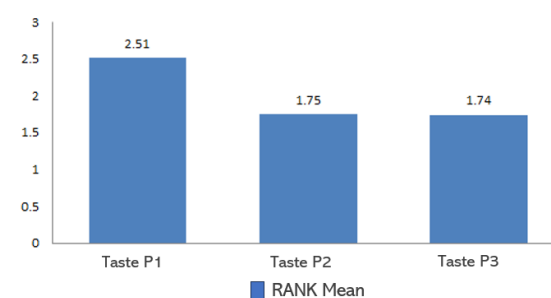


Fig.5. Descriptive statistics regarding the taste of the products.

To determine which product has the significantly better smell, we refined two-by-two sample comparisons by applying the non-parametric Wilcoxon Sign Rank test and found that P1 has a significantly better smell than P3 ($p=0.016$) and then P2 ($p<0.001$), and P3 has significantly better smell than P2 ($p=0.04$) (Fig.6).

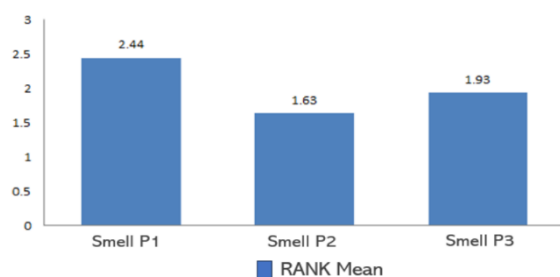


Fig.5. Descriptive statistics regarding the smell of the products.

Pair-by-pair comparison of the products, according to each characteristic, was performed with the non-parametric Mann-Whitney U Test. The results of the Mann-Whitney test when comparing P1 with P2 (Table.1.), P1 with P3 (Table.2.) and P2 with P3 (Table.3.) are as follows:

Table.1. Results of the Mann-Whitney test when comparing P1 with P2.

Characteristic	Product	N	Mean Rank	Sum of Ranks	p-value
Aspect	P1	54	61,44	3318,00	0,012
	P2	54	47,56	2568,00	
	Total	108			
Consistency	P1	54	53,73	2901,50	0,782
	P2	54	55,27	2984,50	
	Total	108			
Flavour	P1	54	57,59	3110,00	0,272
	P2	54	51,41	2776,00	
	Total	108			
Taste	P1	54	54,94	2967,00	0,872
	P2	54	54,06	2919,00	
	Total	108			
Smell	P1	54	60,17	3249,00	0,041
	P2	54	48,83	2637,00	
	Total	108			

Table.2. Results of the Mann-Whitney test when comparing P1 with P3.

Characteristic	Product	N	Mean Rank	Sum of Ranks	p-value
Aspect	P1	54	55,17	2979,00	0,803
	P3	54	53,83	2907,00	
	Total	108			
Consistency	P1	54	63,46	3427,00	0,002
	P3	54	45,54	2459,00	
	Total	108			
Flavour	P1	54	66,81	3607,50	<0,001
	P3	54	42,19	2278,50	
	Total	108			
Taste	P1	54	67,06	3621,00	<0,001
	P3	54	41,94	2265,00	
	Total	108			
Smell	P1	54	62,08	3352,50	0,005
	P3	54	46,92	2533,50	
	Total	108			

Table.3. Results of the Mann-Whitney test when comparing P2 with P3.

Characteristic	Product	N	Mean Rank	Sum of Ranks	p-value
Aspect	P2	54	49,03	2647,50	0,050
	P3	54	59,97	3238,50	
	Total	108			
Consistency	P2	54	46,50	2511,00	0,052
	P3	54	52,50	3075,00	
	Total	108			
Flavour	P2	54	39,80	2149,00	0,071
	P3	54	49,20	2737,00	
	Total	108			
Taste	P2	54	42,04	2270,00	0,092
	P3	54	56,96	2616,00	
	Total	108			
Smell	P2	54	42,44	2292,00	0,108
	P3	54	53,56	2594,00	
	Total	108			

Hence, based on the results of the Mann-Whitney test for the comparison between products P1 and P2, it is evident that the appearance and scent of product P1 are significantly superior to those of product P2.

Furthermore, the Mann-Whitney test reveals that when comparing product P1 with P3, the consistency, aroma, taste, and smell of product P1 are notably better than those of product P3.

Lastly, the Mann-Whitney test comparison between products P2 and P3 indicates that there are no significant distinctions between them across any of the five evaluated criteria.

From a nutritional standpoint, the two recipe variants are comparable to other natural or dietetic products available on the market. The moisture content of recipes P1 and P2, expressed in g/100g, is 4.08% and 3.85%, respectively. Mineral substances (g/100g): 5.86 and 5.03; crude protein (g/100g): 11.114 and 11.45. Total lipids (g/100g) are 9.56 and 9.04, of which saturated fatty acids are 6.42 and 6.13. Carbohydrates - total by difference (g/100g): 69.36 and 71.63, of which sugars: 15.35 and 15.85, and fibers: 28.37 and 29.30.

The energy value (kcal) - calculated: 408.04 for P1 and 404.68 for P2. It is observed that both product variants have very close values in terms of protein, lipid, and carbohydrate content.

Furthermore, a reduced sugar content and a high dietary fibre content are noted in both recipe variants [11,12]. The two designed recipes were tested alongside a control sample, representing product P3. The control sample was the commercial hot chocolate "La Festa"; it represents an instant beverage based on cocoa and milk. It contains: sugar, cocoa powder (dry cocoa matter: min. 15%), cocoa butter 10-12%, whey powder, glucose syrup, fully hydrogenated coconut vegetable fat, skimmed milk powder 2%, salt, thickening agent: carboxymethylcellulose, flavours, emulsifier: soy lecithin, stabilizer: potassium phosphates. From a nutritional perspective, the commercial hot chocolate, "La Festa," has a calorie count of 391 kcal/100g, with a total of proteins 5.3; lipids 5.4; carbohydrates 77.6; fibres 5.1.

CONCLUSIONS

1. **Sensory Evaluation Superiority of Recipe P1:** The study's findings, based on sensory evaluations and statistical analysis (Mann-Whitney and Wilcoxon Sign Rank tests), demonstrate that recipe P1 (Red Recipe) exhibits significantly better characteristics in terms of appearance, consistency, flavor, taste, and smell compared to P3 (commercial hot chocolate "La Festa") and P2 (Green Recipe).
2. **Nutritional Analysis of Recipes P1 and P2:** Both hot chocolate recipes P1 and P2 are nutritionally similar to other natural or dietetic products on the market. They have closely comparable values in terms of protein, lipid, and carbohydrate content, with a notable feature being their reduced sugar content and high dietary fiber, which could be beneficial for health-conscious consumers.
3. **Comparative Analysis with**

Commercial Hot Chocolate: When compared to the commercial hot chocolate sample (P3), both P1 and P2 show distinct advantages in terms of sensory attributes. However, statistically, there are no significant differences between P2 and P3 across the evaluated criteria. This indicates that while P1 stands out in sensory qualities, P2 is more comparable to the commercial product in these respects.

These conclusions highlight the strengths of the newly developed hot chocolate recipes, especially P1, in sensory appeal and nutritional profile, positioning them as potentially favourable alternatives in the health-conscious market segment.

Acknowledgements

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